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WAR DEPARTMENT TECHNICAL MANUAL

U.S. Dept. of Army

**CARDIOGRAPH,
PORTABLE**



WAR DEPARTMENT TECHNICAL MANUAL
TM 8-614

CARDIOGRAPH, PORTABLE



WAR DEPARTMENT • *2 OCTOBER 1944*

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WAR DEPARTMENT,
WASHINGTON 25, D. C., 2 October 1944.

TM 8-614, Cardiograph, Portable, is published for the information and guidance of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIQ,
Major General,
The Adjutant General.

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For explanation of symbols, see FM 21-6.

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CONTENTS

TM Q-614
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CHAPTER 1. GENERAL.

Scope.....	1	1
Description.....	2	2
Manufacturers.....	3	2

CHAPTER 2. GENERAL ELECTRIC MODEL "B".

Section I. Packing and assembling.

Unpacking and assembling.....	4	3
Disassembling and packing.....	5	3

II. Operation.

Description of controls.....	6	3
Preliminary tests.....	7	6
Making the electrocardiogram.....	8	7

III. Maintenance.

Testing the batteries.....	9	12
Replacement of batteries.....	10	13
Replacement of galvanometer lamp,.....	11	14
Timing the motor.....	12	16

IV. Repair.

General.....	13	19
--------------	----	----

CHAPTER 3. SANBORN CARDIETTE.

Section I. Packing and assembling.

Unpacking and assembling.....	14	22
Disassembling and packing.....	15	22

II. Operation.

General.....	16	22
Preliminary tests.....	17	22
Making the electrocardiogram.....	18	24
Replacing photographic paper.....	19	25

III. Maintenance.

Testing the batteries.....	20	27
Replacement of batteries.....	21	28
Replacement of galvanometer lamp.....	22	29
Timing the motor.....	23	29

IV. Repair.

General.....	24	30
--------------	----	----

Appendix. Item 36260 Cardiograph, Portable, Standard Nomenclature List of Parts, General Electric X-ray Corporation, Model No. B.....

1	31
---	----

Item 36260 Cardiograph, Portable, Standard Nomenclature List of Parts, Sanborn Instomatic.....

2	32
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CHAPTER 1

GENERAL

1. SCOPE. **a.** This manual is published for the information and guidance of all personnel charged with the operation and maintenance of the Portable Cardiograph, Medical Department Item No. 36260 (fig. 1) in the field. It includes instructions for assembling, operating, first and second echelon maintenance, and packing the portable electrocardiograph.

b. A standard nomenclature list of parts has been appended for each manufacturer. These lists include only those parts which should be replaced in the field.

c. The optical and electrical systems of the cardiograph are delicately adjusted at the factory, and should not be changed or adjusted in the field. Whenever such adjustments or repairs are necessary, the instrument should be returned to the base depot, thence to the zone of the interior.



Figure 1. Portable cardiograph, General Electric Model "B."

2. DESCRIPTION. **a.** The portable cardiograph is an instrument for recording the minute electrical voltages developed during heart actions. The unit incorporates the integral parts of the amplifier, the control circuit, and the power unit, and provides for the accommodation of accessory devices necessary for making an electrocardiographic tracing.

b. The power source for the unit consists of *A*, *B*, and *C* batteries.

3. MANUFACTURERS. **a.** The GE Model "B" Electrocardiograph is manufactured by the General Electric X-ray Corporation, Chicago, Illinois.

b. The Cardiette is manufactured by the Sanborn Company, Cambridge, Massachusetts.

CHAPTER 2

GENERAL ELECTRIC MODEL "B"

Section I. PACKING AND ASSEMBLING

4. UNPACKING AND ASSEMBLING. The cardiograph is packed as a complete unit and is ready to operate after unpacking. Great care should be used in unpacking as this instrument is delicately adjusted, and parts of it are easily broken by rough handling. While unpacking, check the following list of items which are provided as standard equipment:

- 1 Crank
- 3 Standard electrodes
- 3 Perforated rubber electrode bands
- 1 Precordial lead electrode
- 6 Cardiomounts
- 1 Roll of cardiopaper
- 2 Tubes of cardiograph electrode paste
- 1 Spare galvanometer bulb
- 1 Neon bulb

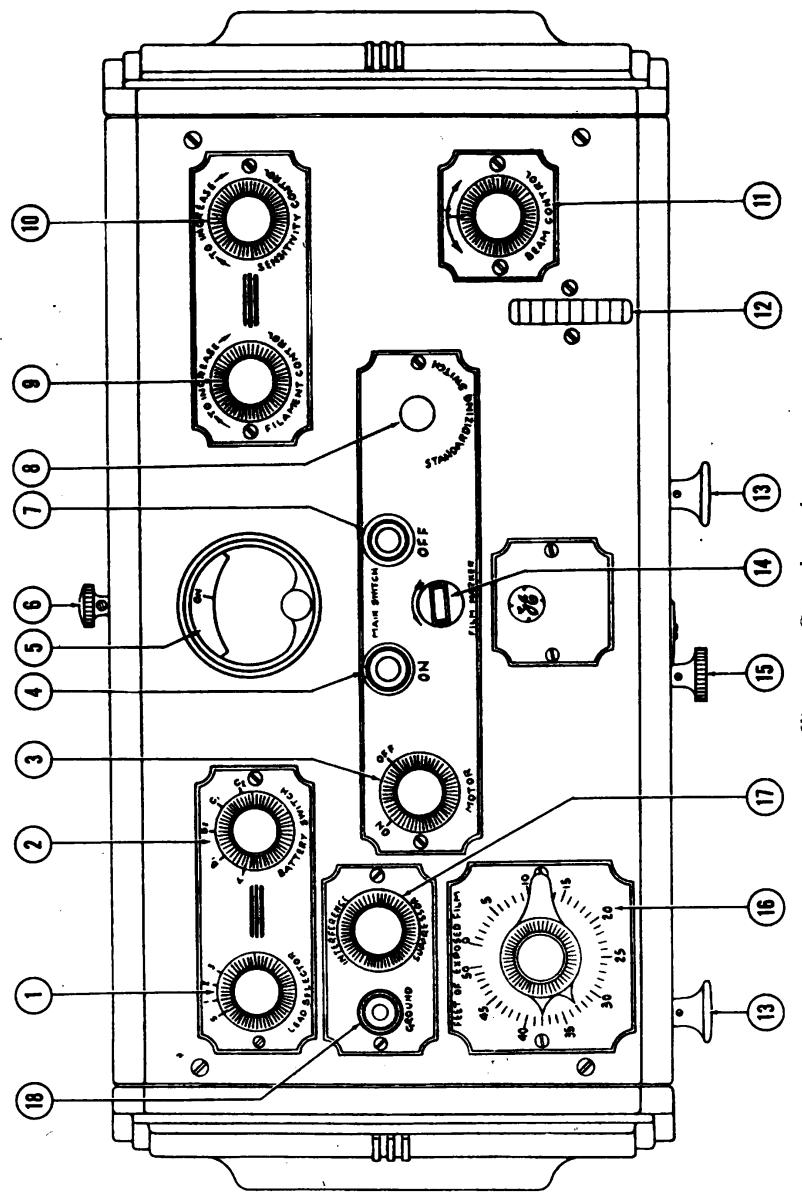
5. DISASSEMBLING AND PACKING. Place crank, patient's leads and electrodes in drawer at bottom of case. Cardiograph should then be carefully crated, giving particular attention to protection of instruments and controls on the top panel.

Section II. OPERATION

6. DESCRIPTION OF CONTROLS. While the various controls and devices with which this instrument is equipped are either appropriately identified or their use is obvious, the following description and identification is presented to avoid any possibility of question as to their function or manipulation.

a. Main Switch (fig. 2, parts 4 and 7). The main switch is of the tapered plug type. To turn the instrument on, lift the tapered plug out of "off" receptacle (fig. 2, part 7) and place in the one labeled "on" (fig. 2, part 4) pushing it down firmly and then turning slightly clockwise. This will wedge the plug into position and insure firm contact.

b. Filament control (fig. 2, part 9). The filament control varies the voltage of the filaments of the amplifier tubes and of the standardizing circuit and should be so adjusted that the voltmeter needle (fig. 2, part 5) coincides with the calibration line marked "on." If by adjustment of the filament control the voltmeter needle can be made to read to this position or higher, the A batteries may be assumed to be in satisfactory condition, but if the voltmeter needle does not come up to the "on" position with the filament



Nomenclature

1. Lead Selector.
2. Battery Switch.
3. Motor Switch.
4. Main Switch "On" Receptacle.
5. Voltmeter.
6. Thumbnut for Rear Panel.
7. Main Switch "Off" Receptacle.
8. Standardizing Push Button.
9. Filament Control.
10. Sensitivity Control.
11. Beam Control.
12. Observation Window (Sensitivity Scale).
13. Camera Knobs.
14. Film Marker.
15. Camera Thumbscrew.
16. Footage Indicator.
17. Interference Suppressor.
18. Ground Wire Receptacle.

Figure 2. Control panel.

control turned in a clockwise direction as far as it will go, the *A* batteries should be replaced. When the voltmeter needle reads exactly on the calibration line, the calibration of the apparatus is correct.

c. Voltmeter (fig. 2, part 5). The voltmeter provides a means of assuring correct calibration of the instrument, and in conjunction with the battery switch (fig. 2, part 2) serves to check the voltage of the various batteries in the circuit. For checking the voltage of batteries, the voltmeter needle should read in the range marked "normal." This is explained in greater detail in paragraph 9.

d. Standardizing push button (fig. 2, part 8). Electrocardiographic practice accepts as standard a calibration which causes a beam deflection of 10 millimeters when a potential of 1 millivolt is impressed across the input terminals. Pressing the standardizing push button momentarily impresses 1 millivolt across the input terminals. The resultant beam deflection is readily observable in the observation window or sensitivity scale (fig. 2, part 12). When this deflection is exactly 10-mm, the instrument is said to be standardized or properly calibrated.

e. Sensitivity control (fig. 2, part 10). The sensitivity control determines the overall amplification of the instrument and should be adjusted to obtain a 10-mm deflection. Lower or higher deflection can readily be obtained by turning the sensitivity control in appropriate directions.

f. Lead selector (fig. 2, part 1). While three electrodes are applied to the patient, only two are used in recording any one lead. The four positions in which the lead selector may be placed, designated as S, 1, 2, and 3 respectively, indicate standardization, lead 1 (right arm and left arm), lead 2 (right arm and left leg), and lead 3 (left arm and left leg). With the lead selector switch in position the patient is disconnected from the cardiograph, which permits calibrating or standardizing the instrument without the variations caused by heart action being registered.

g. Observation window (Sensitivity Scale) (fig. 2, part 12). After the light beam leaves the reflecting galvanometer, it is split by a mirror, a portion of the beam being directed onto the observation window (fig. 2, part 12) and the remainder into the camera. Thus is provided a visual indication of the beam action which is simultaneously being recorded on the photographic paper. The position of the beam as recorded on the photographic paper is identical with that observed in the observation window. Thus the operator has a continuous indication of the position of the beam on the paper and can change it at will to suit the circumstances. The lines on the observation window are 5-mm apart and provide a convenient means of determining beam excursions.

h. Beam control (fig. 2, part 11). The beam control is provided to permit the operator properly to orient the baseline with respect to the photographic paper. With some patients the beam excursion is predominantly upward; in others it may be predominantly downward, and in still others almost equally divided between upward and downward deflections. Thus,

to produce the best appearing record, it may be desirable to shift the base-line closer to one edge of the record. This is accomplished by turning the beam control in the appropriate direction. Adjustment of the beam control has no effect on the accuracy or calibration of the record and may, if necessary, be manipulated while the tracing is being recorded.

i. **Motor** (fig. 2, part 3). The motor control starts or stops the driving and timing mechanism. The positions "on" and "off" are plainly indicated.

j. **Film marker** (fig. 2, part 14). The film marker is provided to enable the operator to place a mark on the edge of the record to identify the various leads when such is deemed desirable. Momentarily turning this knob in the direction indicated causes a white mark to be registered on the edge of the record. To indicate lead one, turn the film marking lever once. To indicate lead two, turn it twice, etc.

k. **Interference suppressor** (fig. 2, part 17). The interference suppressor is provided to permit the operator to suppress or minimize the effects of interference picked up by the patient from a-c power and lighting lines and ordinary appliances connected thereto. The ground wire is plugged into receptacle (fig. 2, part 18) only when recording heart action. It should be disconnected when instrument is stabilizing or when standardizing equipment.

l. **Battery switch** (fig. 2, part 5). The battery switch, in conjunction with the voltmeter (fig. 2, part 5) is provided to enable the operator to test the voltage of the various battery units and determine when replacement is indicated. This is explained in greater detail in the section on maintenance. Except when testing, this switch should always remain in the position marked "A."

m. **Footage indicator** (fig. 2, part 16). The footage indicator serves to indicate the amount of paper exposed for each lead and also the number of feet of paper remaining in the camera. The upper index is fixed to and turns with the knob when the motor is in motion. This index indicates at any time the number of feet left in the camera provided that it was set at "0" on the dial when fresh roll was inserted in the camera and its setting was not disturbed subsequently by turning the knob. In conjunction with the lower index it also can be used to indicate the amount of paper exposed for each lead.

7. PRELIMINARY TESTS. After unpacking the electrocardiograph and before taking a tracing, a few preliminary tests should be made to ascertain that the instrument is in proper operating condition.

a. Open back door and remove the cover from the battery compartment. Make sure that the A and B battery terminals are tight. If terminal nuts have loosened during transportation, tighten them first by hand and finish tightening them with a pair of pliers, but be careful not to break the seal on the batteries.

b. Set the lead selector on position "S." Ascertain that the battery switch is set on position "A."

c. Turn on the main switch, rotate the filament control in a clockwise direction and note the reading of the voltmeter. With the filament control turned as far as it will go, the voltmeter needle should pass the "on" mark at least an eighth of an inch.

d. Adjust the filament control until the voltmeter needle reads exactly "on." About 1 minute is required for stabilization. During this time, the beam does not remain stationary. When the unit is completely stabilized, the beam will remain stationary and can be brought to the center of the observation window by turning the beam control in the proper direction. In this position, it should remain perfectly motionless.

e. Turn off the main switch and turn the battery switch to each of the positions indicated. In each of these positions, the voltmeter should read within the range marked "normal."

f. Turn the motor on and off to make sure it runs. It is possible to stop the motor in a position in which one of the time marker blades intercepts the beam of light; thus giving an appearance of no beam in the observation window. If the beam cannot be located in the observation window, start and stop the motor.

8. MAKING THE ELECTROCARDIOGRAM. **a. Loading the camera.** Remove the camera (fig. 3) from the cardiograph by first unscrewing the chromium-plated thumbscrew (fig. 2, part 15) and then withdraw the camera by pulling out on the two knobs (fig. 2, part 13). Place the camera on a bench or table in the darkroom with the three knobs down. Unscrew the thumbnut in the lower center of the camera and lift the cover off. This exposes the entire working mechanism and allows the camera to be loaded.

(1) The cardiograph paper used is supplied in rolls of 50 feet by 45 millimeters wide. It is coated on one side with photographic emulsion and will be ruined if exposed to light; open only in the darkroom. Do not remove the cardboard core on which the paper is wound.

(2) Remove the wrapping from the roll of paper and free the start end which is stuck to the roll. Push the friction lever (fig. 3, part 5) out of the way and lift out the spool (fig. 3, part 1). Insert the spindle of the spool into the new roll of cardiopaper, making certain that when facing the disc side of the spool, the cardiograph unwinds upward on the left side, so that when replaced in the camera, the paper strip may be passed over the slide (fig. 3, part 2) with the emulsion side toward the slide. Press the spring clip (fig. 3, part 4) in the receiving spool (fig. 3, part 3) with a finger and pull the end of the paper under it as illustrated in figure 3.

(3) Now rewind the cardiopaper on the unexposed roll by turning the roll backwards as far as it will go without pulling it out of the spring clip in the receiving spool. This will bring the slot in the receiving spool as close as possible to the end of the slide and will hold the paper taut across the slide. The camera case may now be replaced.

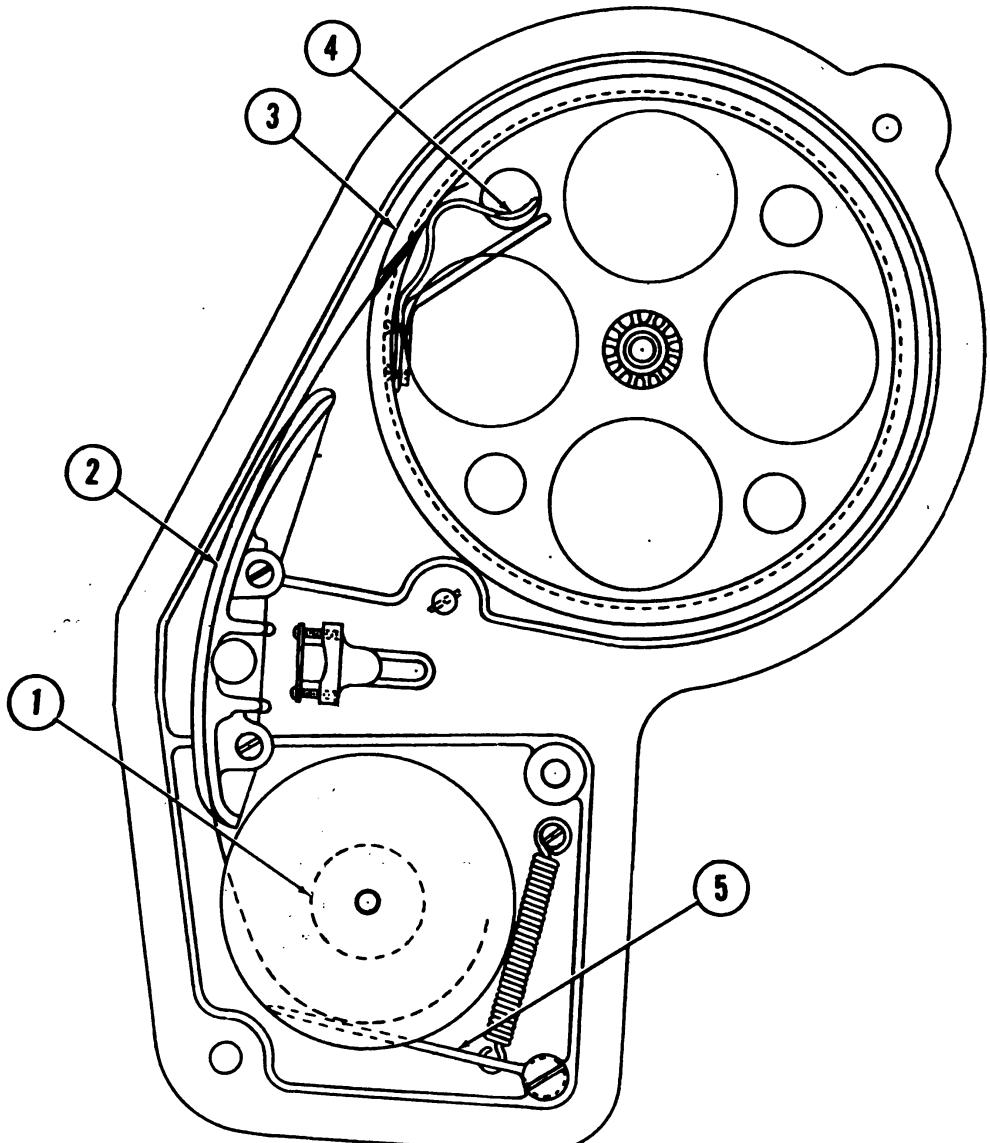


Figure 3. The camera.

(4) The camera case is secured to the camera proper by means of a single thumbnut and is designed to permit easy assembly. It is suggested that before loading, the camera be examined in daylight by everyone who is to use it so that they may be familiar with its construction. This will greatly facilitate manipulation in the darkroom.

(5) When replacing the camera in the electrocardiograph, do not force. It is possible for the position of the gear teeth which constitute the coupling mechanism in the camera and in the motor assembly to fail to mesh, in which case, the camera cannot be readily inserted.

(6) If the camera does not go into place readily, start and stop the motor which will change the relation of the two halves of the coupling gear and permit the camera to be easily inserted. If the camera is jammed into position it may lock the motor. Under this condition a tracing cannot be

made. After replacing the camera, tighten the thumbscrew (fig. 3, part 15). Start the motor and allow it to run for approximately 2 seconds before turning on the main switch.

b. Winding the motor. (1) Insert the crank for winding the motor in the hole provided in the rear panel. Turn the crank in a counterclockwise direction (when facing the rear panel) and continue winding until the crank is stopped. Do not force beyond this point. The crank should be removed when operating the motor.

(2) Although the motor is designed to drive at least 30 feet of cardio-paper without rewinding and without introducing appreciable inaccuracies, it should be rewound at least every 20 feet of paper run or equivalent motor operation. By following this practice, any possibility of the motor running down while making a tracing will be eliminated. Not more than 20 feet of paper should be run onto the receiving spool. More than 20 feet may cause difficulty by forcing too much paper on to the receiving spool. If a 14 x 17 X-ray film hanger is used for developing, the paper should be removed every 15 to 18 feet. More than this cannot conveniently be placed on this hanger.

c. Turning on the apparatus. In order that the instrument may reach stable condition, the main switch should be turned on at least 3 minutes before the tracing is taken. This allows ample time for connecting the electrodes and positioning the patient.

(1) Be sure that the lead selector is on the position "S" and the battery switch is on position "A." Lift the main switch plug from the "off" receptacle, insert it to the "on" receptacle and wedge it in place by turning it clockwise. Adjust the filament control slightly to the right of the "on" mark on the voltmeter.

(2) By the time the patient is connected and the 3-minute period has elapsed, readjust the filament control, if necessary, so that the voltmeter needle is exactly on the "on" line. As soon as the beam stabilizes or becomes stationary on the calibration scale, the instrument is ready for calibration.

(3) The calibration scale, as seen in the observation window, should be illuminated as soon as the main switch is turned on. If it is not, it is because one of the blades of the timer has stopped in a position in which it intercepts the beam of light. To correct this condition, start and stop the motor. If this does not correct condition, open back door and note if galvanometer bulb is lighted. If bulb does not light, it is probably burned out and should be replaced.

d. Connecting the patient. The patient's electrodes, rubber electrode bands, connecting cable and electrode paste are kept in the drawer in the base of the machine. The electrodes, bands, and paste should be removed and the connection cable brought out through the slot in the center of the drawer. This permits the drawer to be kept closed while the record is being made. The electrodes are readily disconnected from the cable and thus

may be applied more easily to the patient. To prepare the electrodes, attach the perforated rubber bands to the two hooked prongs of each electrode.

(1) The electrodes are to be applied to a flat portion on the inside of the right and left forearms and calf of the left leg. Select an area that conforms to the contour of the electrodes as nearly as possible, so that good contact over the entire electrode area may be secured. Apply a small amount of paste (about $\frac{3}{4}$ inch) from the tube to the skin area selected. Rub the paste vigorously into the skin for 5 to 10 seconds, covering an area slightly larger than that of the electrode.

(2) Apply an additional quantity of paste (about $\frac{1}{2}$ inch) and spread evenly over the rubbed area. Fasten the electrode with the perforated elastic strap, firmly but not too tightly. If the band is pulled too tightly, the muscles will become constricted and prevent complete relaxation which is essential if a good record is to be obtained. On the other hand, if the electrodes are bound too loosely, poor contact may result with a consequent uneven baseline on the tracing.

(3) Connect the lead wires of the patient's cord to the proper electrodes, following the markings on the patient's cable terminals. Fasten the thumbscrews securely.

(4) The electrocardiogram may be made with the patient either in a sitting or reclining position. The patient's hands should not touch each other and the legs should not be crossed. The arms and legs should not be excessively flexed or complete relaxation cannot be obtained. If the patient is wearing clothing which is tight, better results may be obtained if it is loosened. Care must also be exercised that no constriction of extremities occurs when the patient's clothing is rolled up for the application of electrodes.

e. Standardizing. If the main switch was turned on before the electrodes were applied, the apparatus should be stabilized by the time application of the electrodes is completed. If this is true, the beam should appear stationary in the observation window and the instrument is ready for standardization.

(1) If the calibration scale is not illuminated the beam cannot be seen. In this event, start and stop the motor which should cause the scale to become illuminated. If with the scale illuminated the beam cannot be seen, turn the beam control until the beam comes into view.

(2) Manipulate the beam control so that the near edge of the beam is made to coincide with the first line on the far side of the center position of the calibration scale in the observation window. Press momentarily the standardizing button which causes the beam to deflect toward the operator. Adjust the sensitivity control so that when the standardizing button is pressed a beam deflection of two divisions on the scale, which represents 10-mm, is obtained. The beam excursion should be measured from near edge to near edge. When the sensitivity control is moved, the beam will change its position and should be corrected by means of the beam control.

(3) With the instrument thus properly standardized, a record of standardization should be made as follows:

(a) Start the motor and allow to run for approximately 2 seconds.

(b) Press momentarily the standardizing push button.

(c) Allow the motor to run for approximately 1 second and turn off.

(4) This will produce a standardization record approximately 3 inches long, containing one excursion of the beam which, if standardization adjustment has been properly made, should show a deflection of exactly 10-mm. If desired, two, three, or more standardization marks may be recorded. If through error the instrument has not been properly standardized to produce a 10-mm deflection when the standardizing push button is pressed, no inaccuracy in tracing will result. In such a case, it is only necessary to remember that the excursion as registered on the standardization regardless of what this may measure, is the excursion produced by a potential of one millivolt, and correction may be made accordingly. For instance, if the standardization mark is 11-mm instead of 10, it is 10 percent too high. Correction can thus be made.

f. Taking a tracing. Standardization having been completed, change the lead selector to position 1. This connects the right arm and left arm of the patient to the instrument. After changing the position of the selector switch, the beam may wander over the calibration scale, but should settle down in most cases within a short time (approximately 10 seconds). The excursions of the beam produced by heart action will be seen in the observation window.

(1) As soon as the beam has settled down, manipulate the beam control to center the beam excursions so that the excursion in either direction is approximately the same distance from the edge of the observation window. While this adjusting in no way affects accuracy, a much neater appearing record will be obtained if the tracing is properly centered.

(2) Turn by means of resettable arm the lower index until it coincides with the upper index. Start the motor and allow it to run until the required amount of paper has been exposed for the first lead. This corresponds to the upper index travel over one division on the scale. After the upper index has traveled a distance equivalent to one division on the scale from the lower index, turn off the motor.

(3) Repeat this procedure with the selector switch on position 2 and position 3, allowing a short time after each change in lead selector switch position for the beam to stabilize. Lead 2 connects the right arm and left leg of the patient, while lead 3 connects the left leg and left arm.

(4) Occasionally a patient is encountered who causes the beam to move slowly back and forth. In such a case, free use of the beam control should be exercised to hold the beam on the calibration scale.

g. Identification of lead. The lead marker is provided for identification of the different leads. Three or four seconds after the motor is started for

taking the first lead, turn the lead marker knob momentarily counterclockwise. This will produce a white mark along the bottom of the paper. To mark lead 2, turn the lead marker twice in succession. Similarly, lead 3 is marked by turning the lead marker three times in succession. If identifying marks are desired throughout the length of the tracing, actuate the lead marker the corresponding number of times at intervals as long as the motor is running. This will result in a series of white marks along the bottom of the record.

h. Disconnecting the patient. On completion of the tracing, place the main switch in the "off" positions and change the lead selector switch to position "S." To insure that all of the exposed parts of the paper are beyond the point where it will be cut off, run the motor for approximately 2 seconds after the last tracing has been completed. Disconnect the patient's leads by loosening the thumbscrews and removing the leads. Remove the electrodes and wipe the patient's arms with a damp cloth. Rinse electrodes and rubber bands in warm running water and allow to dry.

i. Use of the precordial electrode. (1) The precordial electrode can be used in either of two ways. It can be held by means of the insulated handle, or the handle may be unscrewed and the electrode held by hand. In the latter case, it is recommended to interpose a piece of cloth folder into two or three thicknesses between the electrode and the hand. If desired, a small sand bag may be used instead of the hand for holding the electrode in place provided the patient is in a reclining position.

(2) Electrode paste should be applied to the chosen area in the precordial region in the usual manner. Either the patient or the operator can hold the electrode in place.

Section III. MAINTENANCE

9. TESTING THE BATTERIES. The voltage of the batteries used in this unit can be readily checked by means of the battery test switch. The voltage for each group of batteries is indicated by the reading of the voltmeter on the control panel.

a. To test the A battery, turn the main switch on, then turn the filament control in a clockwise direction as far as it will go. The voltmeter should pass the "on" position and read within the range marked "normal." If it does not reach the "on" position, replacement should be made.

b. For testing the other battery units, turn the battery test switch to the corresponding position. In each case the voltmeter should read in the range marked "normal." If on any position the voltmeter does not read within this range, the particular battery indicated by the position of the battery switch, requires replacement, as indicated in paragraph 10.

c. Although this test indicates accurately the voltage of the batteries, it is not necessarily an indication of their internal condition. Occasionally, batteries may be the cause of erratic beam behavior even though the voltage

readings are normal. Replacement of the suspected batteries with new ones will quickly prove whether this is the case. First replace the *B* batteries and note if the beam is steady on the calibration scale. If trouble continues, replace the *A* batteries and finally the *C* batteries.

d. The battery test switch should always be left on position "A" except when testing batteries. If left on other positions, it will cause the batteries to run down.

10. REPLACEMENT OF BATTERIES. The frequency at which batteries will require replacement depends upon the amount of service to which the unit is put. The average life of the *A* batteries is about 20 hours actual operating time. *B* batteries will normally require replacement every 4 to 6 months, oftener if the equipment is used frequently and less often if the equipment is used occasionally. The *C* batteries should normally last approximately 12 months, regardless of the amount of service to which the equipment is placed.

a. The power unit containing the batteries is located in the lower left hand corner when facing the instrument from the rear. To gain access to the batteries, loosen the single thumbscrew in the center of the hinged door and swing the door open. Now loosen the thumbscrew in the center of the power unit cover and remove the cover. This exposes the batteries and permits their replacement.

b. The various batteries are readily identified by referring to figure 4. Two *A* batteries are required. They are identical and are connected in

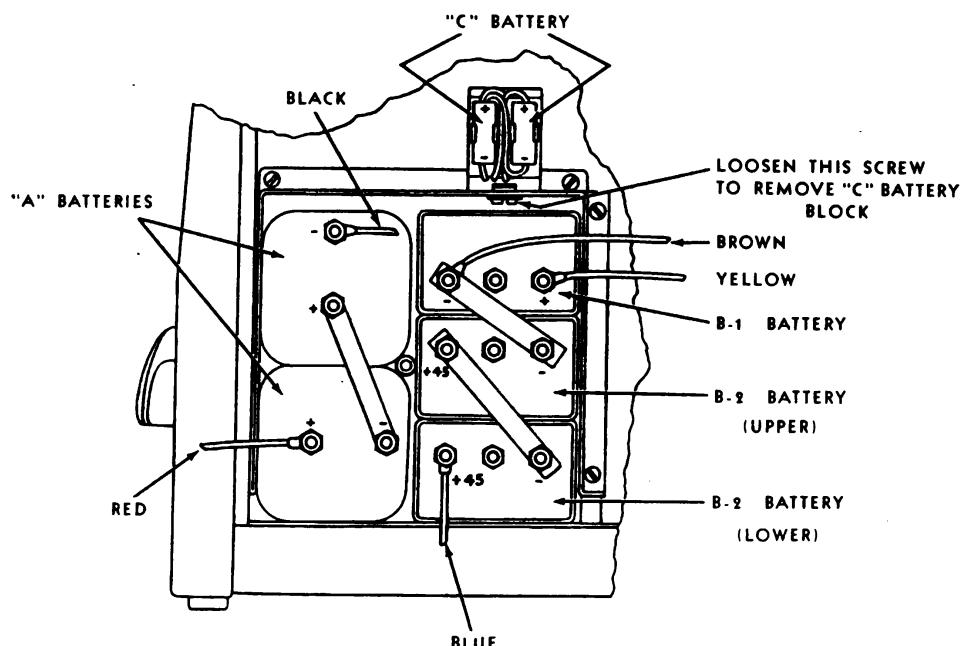


Figure 4. Batteries.

series by means of a metal link. Notice the polarity marking on the batteries. Remove the four nuts from the batteries. Replace the batteries with new ones in the same relative position.

c. Connect the black lead to the negative terminal of the upper battery. Connect the metal link to the positive terminal on the upper battery and to the negative terminal on the lower battery. Connect the red lead to the positive terminal of the lower battery. Screw the four terminal nuts on tightly with a pair of pliers but be careful not to turn the nuts tight enough to break the wax seal on the battery. Loose connections at the terminals of these batteries will cause the beam to be erratic.

d. The various batteries identified in figure 4, correspond with the marking on the battery switch. When the battery switch is placed on position B-1, the voltmeter indicates the voltage of the B-1 battery. On position B-2, the voltmeter reads the combined voltage of the two B batteries connected in series. If B-1 battery is low, it should be changed. If the combined voltage of the two B-2 batteries with the battery switch on position B-2 is below normal, change both B batteries.

e. The B-2 batteries are connected in series by means of a long metal link. Loosen the nuts, remove the connections, then replace with a new set. Place the metal link on the positive 45 volt terminal of the upper B-2 battery and the negative terminal of the lower B-2 battery. Connect brown lead to the negative terminal of the B-1 battery. Connect the blue lead to the positive terminal of the lower B-2 battery. Connect negative terminals of B-1 and upper B-2 batteries by means of a short metal link. Tighten the nuts firmly with pliers but use care not to break the seal.

f. The C batteries are held in position by clips mounted on the terminal board immediately above the battery compartment. To remove the C battery block, loosen the thumbnut from under the top of the battery compartment and slide out the complete unit.

g. Important. Care should be exercised not to allow the C batteries to come in contact with the terminals of the B batteries. It is recommended to place an empty cardboard box next to the B batteries and set the C battery block on top of the box. This will eliminate the possibility of accidental dropping of the C battery unit and burning out of the filaments of the galvanometer lamp and amplifying tubes due to application of the B batteries voltage on the filaments.

11. REPLACEMENT OF GALVANOMETER LAMP. The galvanometer lamp which is the source of the illumination for the optical system, is a special lamp not interchangeable with the standard 2.4 volt lamps. Lamp replacement may at times be required because it has become darkened thus cutting down light intensity. Under these circumstances the intensity of light on the sensitivity scale will be reduced and the records will require longer developing time. A spare lamp has been provided with the cardiograph.

a. Lamp replacement may be affected in a few minutes time. The lamp is housed in a small black cylinder (fig. 5) located in the center of the back compartment near the bottom. To remove the lamp, loosen setscrew (fig. 5)

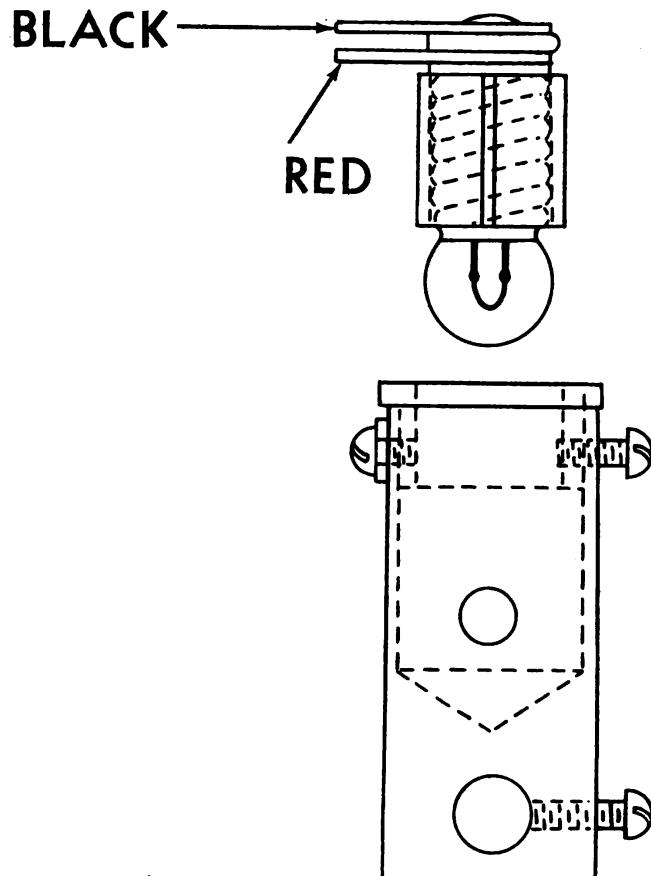


Figure 5. Lamp and housing.

on the upper right hand side of the lamp housing. The lamp and socket can now be readily lifted out. Be careful not to disturb the lamp housing when removing the lamp, and do not loosen any other screws in the housing. The lamp housing was in perfect adjustment when the instrument left the factory and the galvanometer lamp replacement if carefully done will require no further adjustment.

b. Before replacing the lamp, slip the split metal bushing (fig. 5) over the screw shell (fig. 5) of the lamp socket. Screw the lamp (fig. 5) firmly into the socket. Poor contact in the socket will cause an unsteady beam and result in unsatisfactory operation of the electrocardiograph. After screwing the lamp firmly into position, wipe with a clean cloth to remove fingerprints from the lamp.

c. Before replacing the lamp, note that the filament consists of a V-shaped loop of wire. Insert the lamp in the socket in such a manner that the plane of the filament is parallel to the long axis of the cardiograph, that is, so that when facing the lamp from the rear, the full "V" is seen rather than a side view as shown in figure 6. Slip the socket with the lamp into its housing and tighten the setscrew (fig. 6) lightly so that the socket retains

its position and at the same time is loose enough to be moved about for final adjustment.

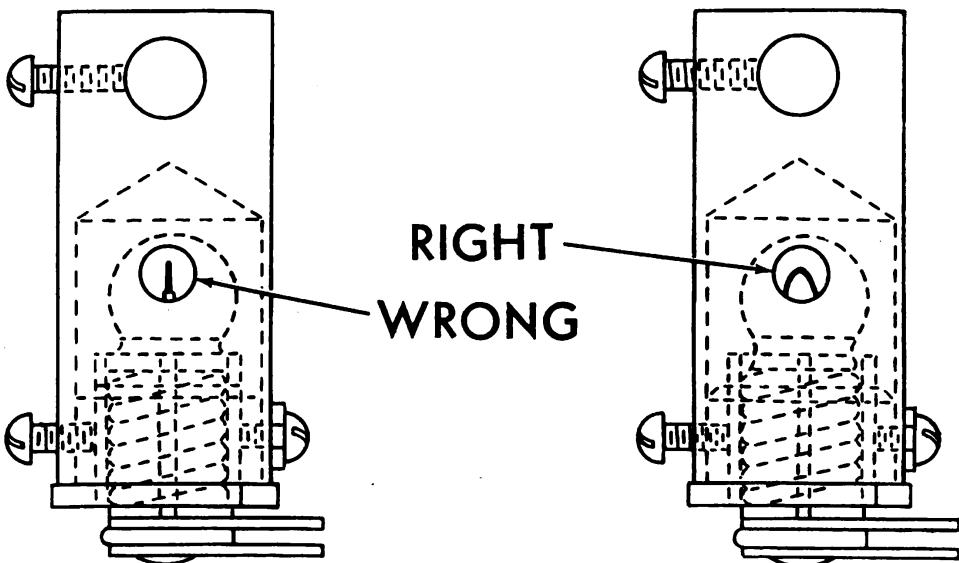


Figure 6. Position of lamp filament.

d. Now remove the camera. With a piece of white paper, cover the inclined mirror farthest from the galvanometer. This will enable you to see the distribution of light when positioning the galvanometer lamp in its housing. Move the lamp up and down in its housing until the light, as observed on the piece of white paper over the area of the mirror and on the calibration scale, is of maximum intensity and is evenly distributed. For this adjustment the beam control should be placed in the central position so that the beam is in the center of the calibration scale. If this movement of the lamp does not suffice to give satisfactory illumination on both the paper over the mirror and on the calibration scale, rotate the lamp in its housing or swing it on its support if necessary. When properly adjusted there will be no color in the illuminated field, as observed on both the paper over the mirror and on the calibration scale, except near the edges where the light ends. As a final check, expose and develop a short strip of cardiopaper. The development tracing should be of uniform and satisfactory density.

12. TIMING THE MOTOR. The spring motor used to drive the paper and to provide motive power for the time line mechanism is initially adjusted to within a fraction of 1 percent accuracy. It should remain in adjustment over a long period of time.

a. A means is provided for quickly and easily checking the accuracy of motor speed and correcting it when necessary. The provision of a means for checking and adjusting does not in any way imply that the mechanism has a tendency to run inaccurately. As with all precision instruments which are

periodically checked, this provision for checking timing accuracy has been provided so that accuracy can be proved, not taken for granted.

b. Two methods of checking timing accuracy are provided; both are simple and accurate. Where alternating current of a uniform frequency, divisible by five (or some other small denominator) is available, the stroboscopic method is recommended. Where suitable alternating current is not available, timing may be checked by means of a stop watch (or an ordinary watch with a second hand if a stop watch is not available) using an index mark provided for that purpose. Whenever checking timing, it is essential that the camera be loaded and in position since the purpose of checking timing is to determine the rate at which the cardiopaper is being passed through the camera rather than the rate at which the motor moves without this load. The main switch should not be turned on. Be sure the motor is properly wound before starting the time check.

c. Stroboscopic method. (1) (a) The stroboscopic method of testing requires the use of a small neon glow lamp supplied with the equipment. This lamp should be screwed into an ordinary electric light extension cord which is then connected to the line. The neon lamp supplied with the equipment is designed for use on 115-volt electric service.

(b) It is important that the frequency of the electric service be exactly the same as the frequency marked on the stroboscopic disc. Unless this exact relationship exists, checking by the stroboscopic method will be in error and the stop-watch method would be preferable. Therefore, open the rear panel to the electrocardiograph and observe whether the frequency stamped on the stroboscopic disc (fig. 7) corresponds to the frequency of the alternating current available.

(c) The bars on the stroboscopic disc are quite conspicuous when the disc is stationary but are indistinguishable when in motion and viewed by ordinary light. If the disc is illuminated by means of the neon glow lamp, the bars on the disc will appear to stand still or move very slowly in one direction or the other. When the motor speed is correctly adjusted, the bars will remain stationary. They may drift slightly forward and then backward but their relative position will remain unchanged.

(2) If the bars appear to move clockwise, the timer is running fast. If they appear to move counterclockwise, the timer is running slow.

(3) To change the motor speed, turn the timing disc (fig. 7) to approximately the position shown in figure 7. Turn the upper knurled nut (fig. 7) to the right to slow down the motor or to the left to speed up the motor. Now turn the timing disc (fig. 7) $\frac{1}{2}$ revolution so that the lower knurled nut (fig. 7) is brought into approximately the same position as the nut just adjusted. Turn this second nut in the same direction and the same number of turns as the first nut. Be sure that whenever an adjustment of motor speed is made, the adjustment is made equally on both the knurled nuts (fig. 7).

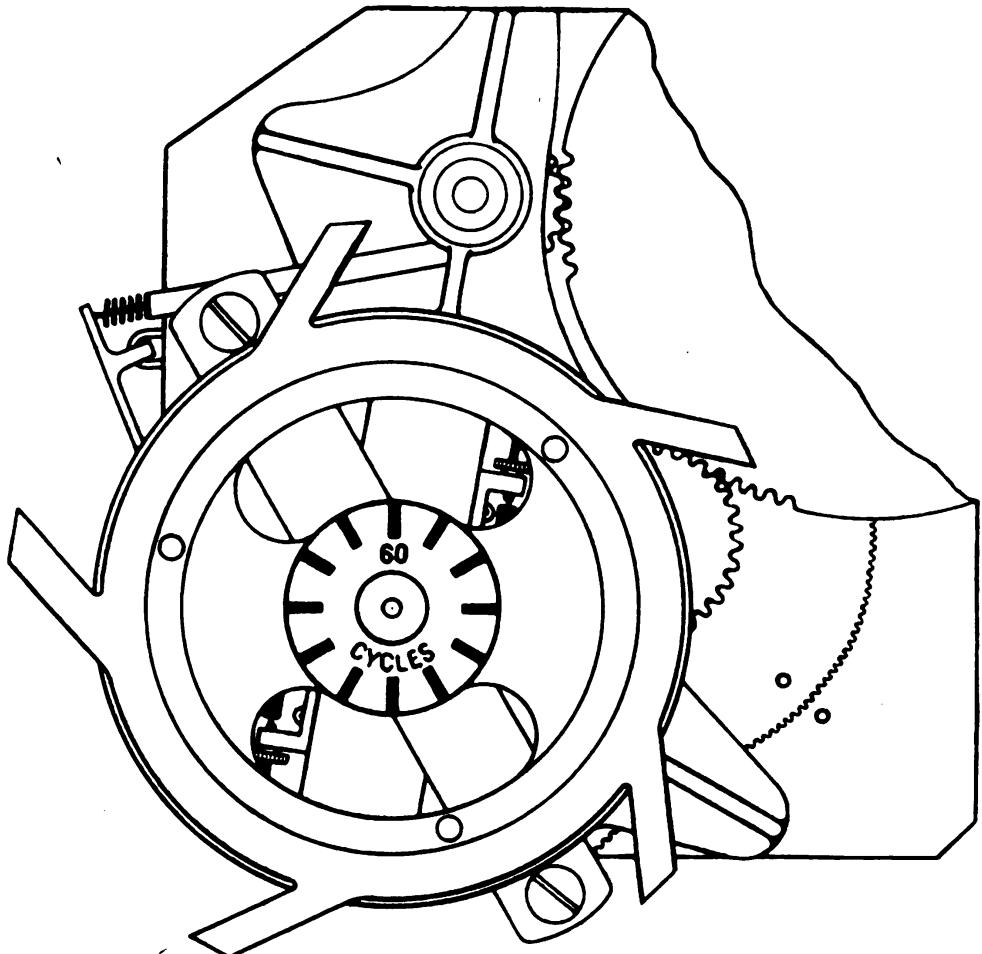


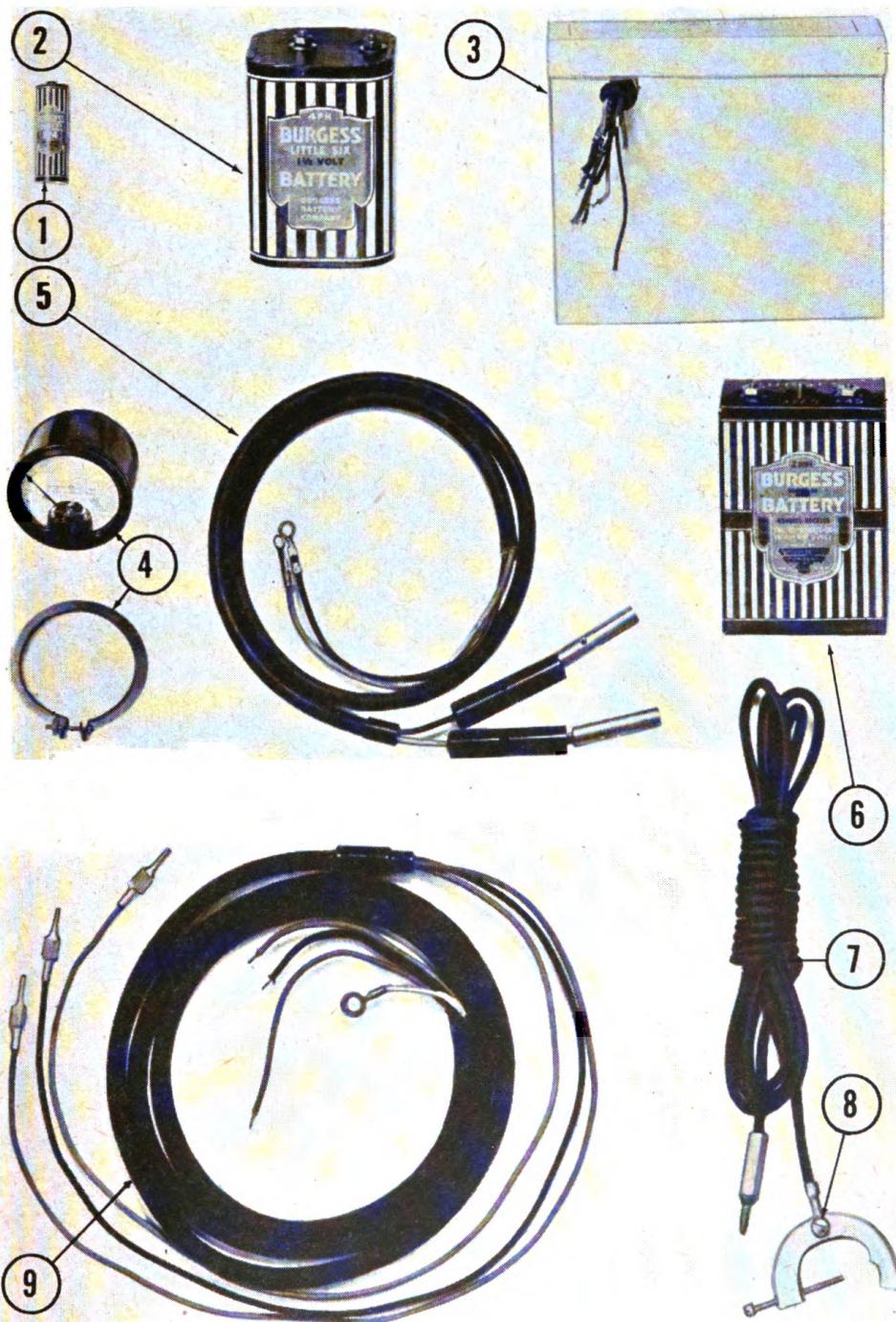
Figure 7. The motor timing adjustment.

d. Stop watch method. (1) The stop watch method involves only the measuring of the time required for the marked gear (below and to the right of the timing disc) to make nine revolutions. An index mark (fig. 7) is placed on this gear and another mark (fig. 7) adjacent thereto on the frame for convenience in noting the number of revolutions. If the motor is running at the proper speed, the time required for this gear to make nine revolutions will be $2\frac{1}{2}$ minutes. If the motor speed is faster or slower than this, it can be corrected by adjusting the knurled nut (fig. 7) as described for the stroboscopic method. A preliminary check can be made by measuring the time required for three revolutions which should be 50 seconds.

(2) While the motor speed was being checked and adjusted, the paper in the camera was being wound on the take-up drum. The paper was not exposed because the main switch was not turned on. To save the paper, the camera should now be removed to the darkroom and the paper rolled back from the take-up drum on to the fresh roll spool.

Section IV. REPAIR

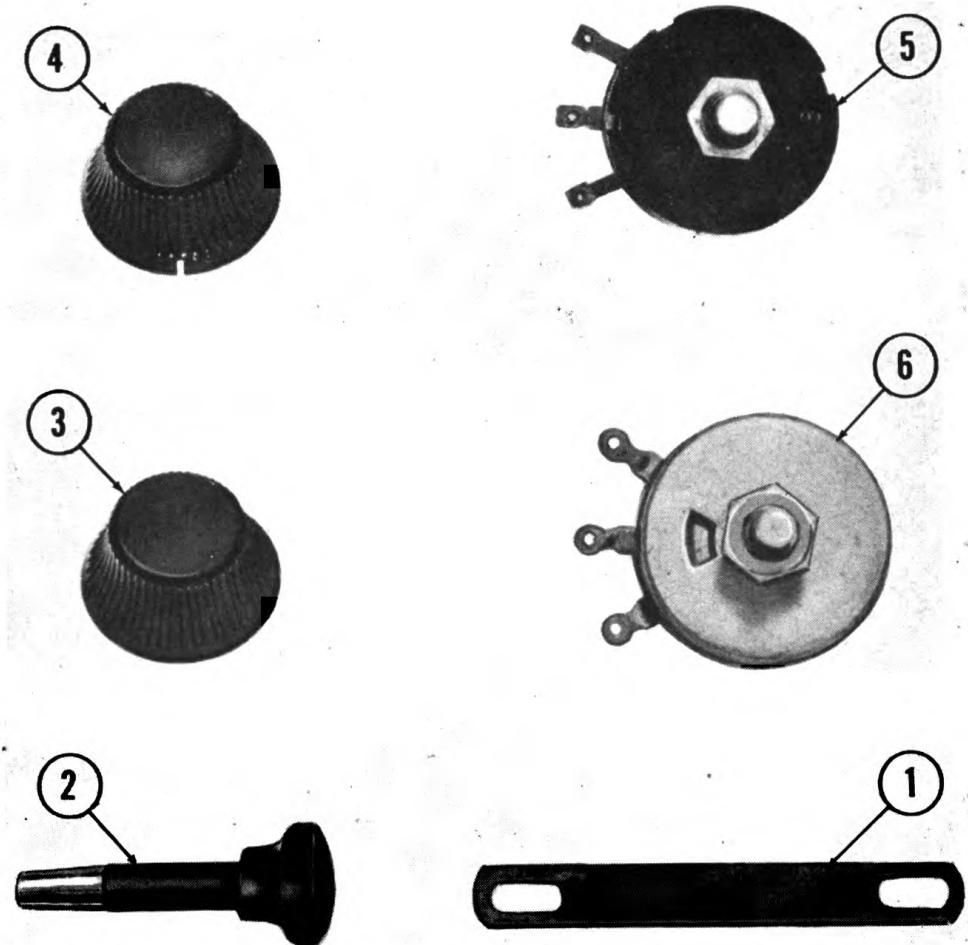
13. GENERAL. Operators should attempt no repairs in addition to the maintenance as already outlined. Many of the adjustments on this instrument are of a delicate nature and should not be changed except by trained medical repair personnel.



- Nomenclature**
1. 77160-02 Battery, Dry Cell: "C"; 1½ Volt; 1 Cell.
 2. 77160-10 Battery, Dry Cell: "A"; 1½ Volt; 1 Cell.
 3. 3R02004 Tube-Pack.
 4. 3R02014 Voltmeter, Type BU.

- Med. Dept. No.**
5. 3R02052 Cable, "A" Battery, Auxiliary.
 6. 77160-26 Battery, Dry Cell: "B"; 45 Volt; 30 Cells.
 7. 3R02022 Wire, Ground, Complete.
 8. 3R02024 Clamp, Ground.
 9. 3R02026 Cable, Patient's, Complete.

Figure 8. Parts for portable cardiograph, General Electric Model "B."



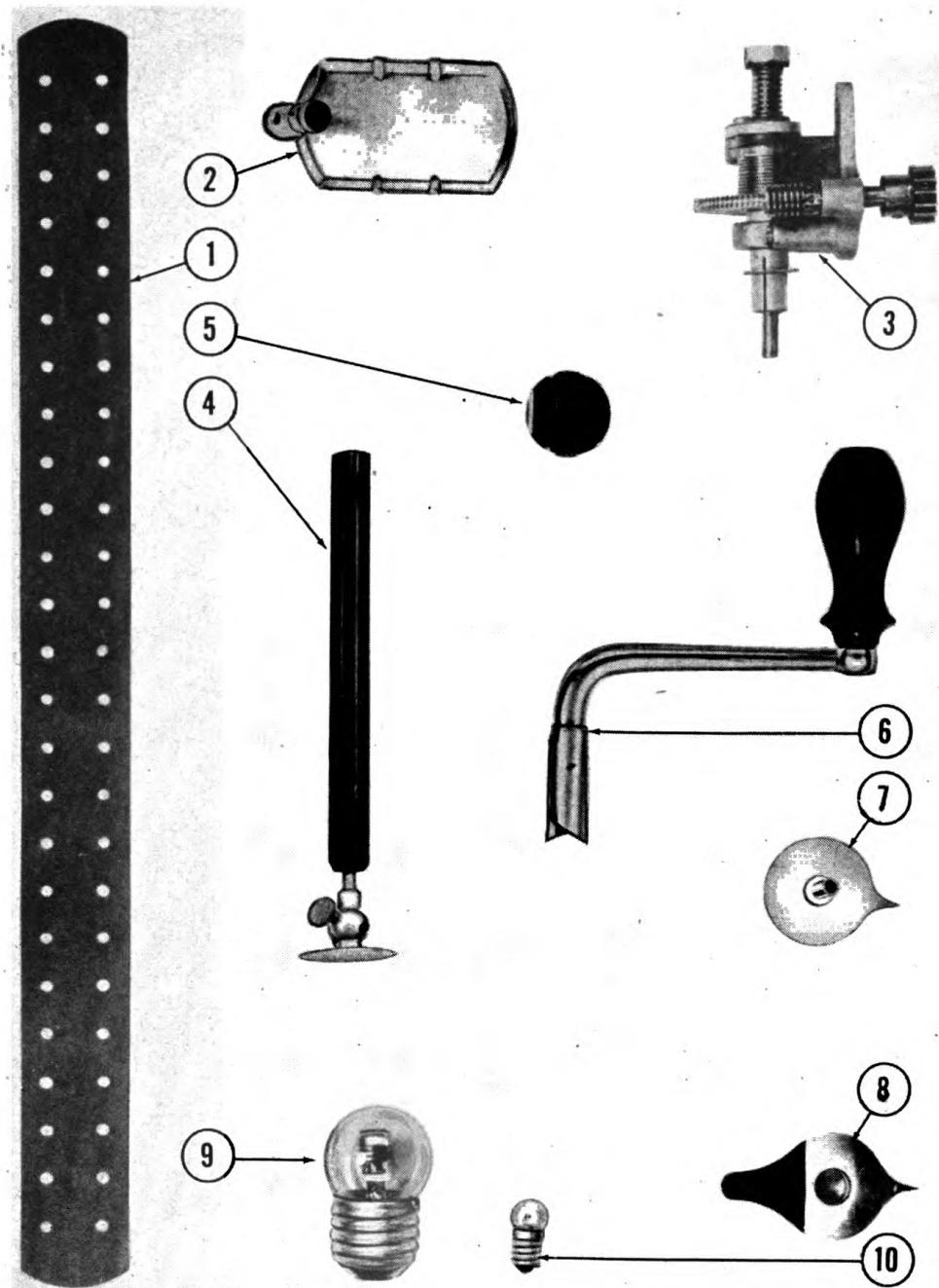
Nomenclature

1. 3R02032 Link, Connecting, Battery.
2. 3R02030 Plug, Main Switch.
3. 3R02034 Knob, Control.

Med. Dept. No.

4. 3R02036 Knob, Control, Indexed.
5. 3R02006 Control, Sensitivity.
6. 3R02008 Control, Filament.

Figure 9. Parts for portable cardiograph, General Electric Model "B."



Nomenclature

1. 3R02012 Band, Arm and Leg, Rubber.
2. 3R02010 Electrode, Patient, Limb Lead.
3. 3R02040 Indicator, Footage, Complete.
4. 3R02016 Electrode, Precordial Lead.
5. 3R02050 Knob, Lead Marker.

Med. Dept. No.

6. 3R02038 Crank.
7. 3R02042 Index, Footage.
8. 3R02044 Index, Advance Setting.
9. 3R02046 Bulb, Neon.
10. 3R02002 Bulb, Galvanometer.

Figure 10. Parts for portable cardiograph, General Electric Model "B."

CHAPTER 3

SANBORN CARDIETTE

Section I. PACKING AND ASSEMBLING

14. UNPACKING AND ASSEMBLING. The cardiette is shipped as a complete unit and is ready to operate after unpacking the following items:

a. Items included in the carton:

- 1 Extra tube electrocardiograph paste
- 1 External battery cable
- 1 Instruction card
- 1 Instruction booklet
- 4 Mounting cards
- 2 Manila envelopes
- 1 Card "To check shipment"

b. Items contained in the cover of the apparatus:

- 3 Limb lead electrodes
- 1 Chest electrode
- 3 Rubber straps
- 1 Tube electrocardiograph paste
- 1 Patient cable
- 5 Extra battery thumbnuts

c. Items included in the apparatus:

- 1 Roll of cardiograph paper
- 1 Extra lamp bulb included with galvanometer bulb unit.

15. DISASSEMBLING AND PACKING. Place patient's electrodes and all leads in their appropriate compartments in the lid of the carrying case. Replace waterproof cover and crate the instrument carefully.

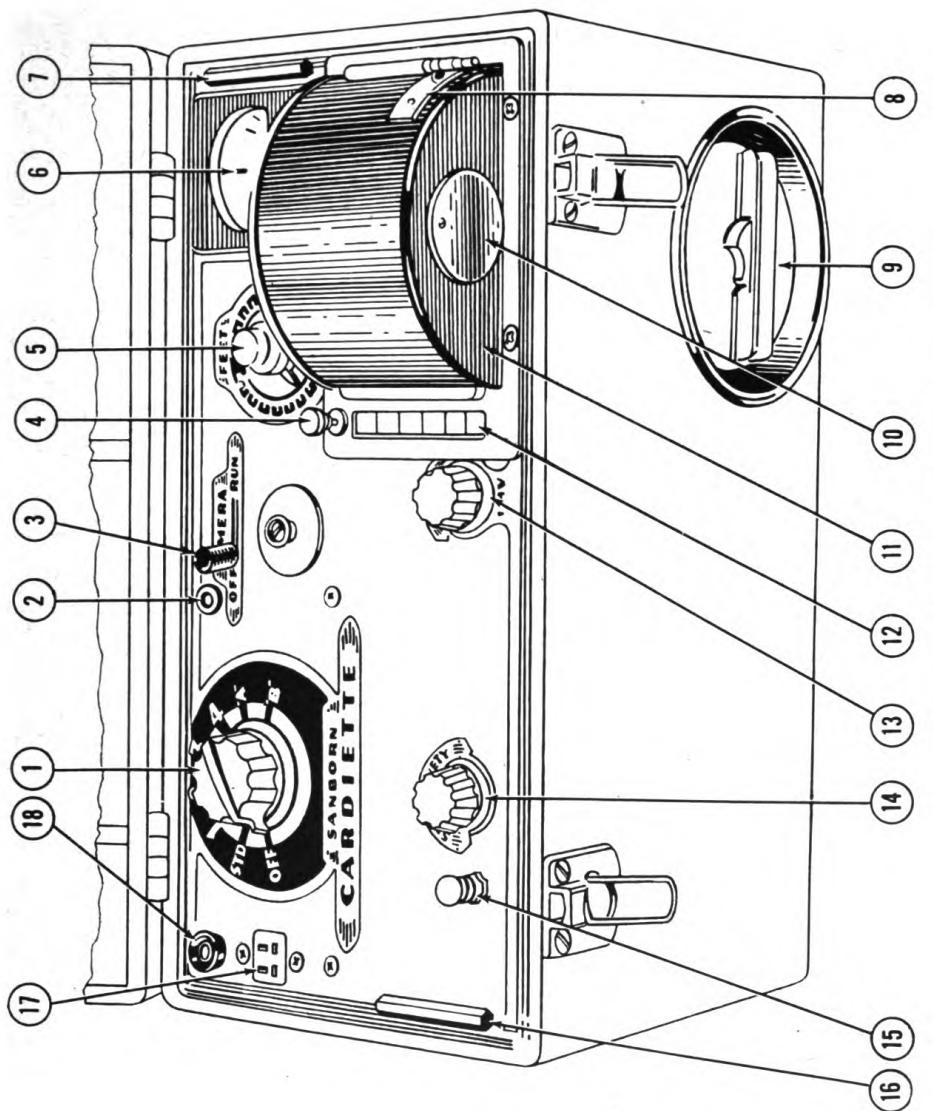
Section II. OPERATION

16. GENERAL. Several aspects of the operation of the Sanborn cardiette are the same as the operation of the General Electric Model "B." Reference is made to Chapter 2 for general operating procedure.

17. PRELIMINARY TESTS. To check the operation of the apparatus, run a preliminary "straight-line" test without a patient as follows:

a. To connect paper. In the middle of the handle of the record container (fig. 11, part 9) is a knob with finger holds. Turn knob clockwise as far as possible and pull out cover.

(1) Slide camera lever (fig. 11, part 3) to "Run" and let an inch or two of paper run into container. The 2-second clock mechanism produces a ticking sound while the camera is running. If it fails to tick, snap lever off and on again. Turn camera off.



Nomenclature

1. Main Switch.
2. Socket for Grounding Panel to Cardioscope.
3. Camera Lever.
4. Lead Marker.
5. Lead Length and Rewind Indicator.
6. Meter for Testing Batteries.
7. Lifting Handle.
8. Autographic Slot.
9. Removable Record Container.
10. Paper Supply Window.
11. Paper Magazine.
12. Viewing Scale.
13. Beam Knob (Also I MV Knob).
14. Sensitivity Knob.
15. Instomatic Button.
16. Lifting Handle.
17. Socket for Patient Cable.
18. Socket for Connecting Cardioscope.

Figure 11. Cardiette operating parts.

(2) In the container (fig. 11, part 9) is a bobbin with a slotted disc. Thread paper in slot nearest opening. Turn camera and allow paper to wind on bobbin two complete turns to prevent paper slipping from slot and jamming in the container.

(3) To replace cover, turn and hold knob until cover is squarely set on container. Then release knob and turn cover by handle until a click signifies that the locking mechanism has engaged. When the cover is properly in place, the handle is horizontal.

b. To standardize. Turn main switch (fig. 11, part 1) to "Std." It will take about 1 minute for the amplifier to reach operating stability. The viewing scale (fig. 11, part 12) should become illuminated and a dark line will be visible.

(1) If the scale does not light, turn beam knob (fig. 11, part 13) until light appears, or turn camera on for an instant to remove one of the camera timer blades from the path of light.

(2) Turn beam knob (fig. 11, part 13) to bring dark line to center of viewing scale (fig. 11, part 12). This dark line is referred to as "beam."

(3) Press I MV knob (fig. 11, part 13) briefly and notice the distance that the beam deflects or "jumps." To get the proper deflection of 1 centimeter (1 space on the glass scale), turn sensitivity knob (fig. 11, part 14) clockwise to increase the deflection or counterclockwise to decrease it.

c. To take record. Draw back autographic slot (fig. 11, part 8) cover and write "Test" with a soft lead pencil.

(1) Set lead length indicator (fig. 11, part 5) at "o." Each short white mark on the dial of the indicator represents 6 inches of paper; each long mark 1 foot. The camera runs 1 inch of paper a second. Turn camera on. Press I MV knob (fig. 11, part 13) to record standardization mark on record. Press lead marker (fig. 11, part 4) once. When taking an actual tracing this would indicate the first lead.

(2) Let camera run until pointer (fig. 11, part 5) reaches the first short mark on the dial. Turn camera lever off (fig. 11, part 3). Turn main switch (fig. 11, part 1) off.

(3) Again start camera, letting it run about one-half small space on dial to bring forward all the record that has been taken.

(4) This test may be cut and developed if desired.

18. MAKING THE ELECTROCARDIOGRAM. **a.** After preparation of patient as described in paragraph 8 of part II, plug patient cable in rectangular socket at upper left corner of panel. Attach patient cable terminals, insert metal pin at end of white terminal marked "RA" into hole of right arm electrode post and tighten screw. Attach black terminal "LA" to left arm electrode, and red terminal "LL" to left leg electrode, in same way.

b. Even when only one lead is desired, always have all three cable terminals connected to the patient to insure proper functioning of the a-c eliminator. If one lead is left disconnected, interference may occur.

- c. After the cardiograph has been standardized and the patient has been connected, turn the lead selector switch to the desired lead, and wait until the beam stabilizes again. In case the instrument being checked is equipped with an instomatic button (located to the left of the sensitivity control) turn the lead selector switch to desired lead while holding down the instomatic button. By using this button, the operator will be able to switch from lead to lead without waiting for the beam to "stabilize." Now turn the camera on to record the lead.
 - d. To make test, draw back autographic slot cover and write patient's name. If more room for more writing is needed, run camera a moment.
 - e. Set lead length indicator at "o." Each small white mark on dial represents 6 inches of exposed paper.
 - f. Check standardization. The beam should deflect exactly 1 centimeter (1 space on viewing scale) per millivolt. No further adjustment of the sensitivity knob during the test should ordinarily be necessary.
 - g. To take leads I, II, and III.
 - (1) Turn main switch to "I."
 - (2) The beam showing the heart beat should pulsate steadily near center of scale. If it swings erratically across the scale, see that the patient is comfortable and not moving the limbs and that the electrode connections are firm. The patient should not talk during the test.
 - (3) Turn camera on.
 - (4) Push down I MV knob briefly to record the standardization.
 - (5) Press lead marker button once briefly to mark Lead I.
 - h. To take leads II and III repeat the procedure, pressing marker button the correct number of times to indicate leads II and III.
 - i. To take leads IV F.
 - (1) To an area on front of chest at outer border of apex, apply a small amount of cardiograph paste and rub well into skin.
 - (2) Place chest electrode over this area. Have patient or assistant hold electrode by its handle.
 - (3) Disconnect RA terminal and attach it to chest electrode.
 - (4) Leave the other connections in place.
 - (5) Turn main switch from 3 to 4 and proceed as for the other leads, marking the "4."
 - (6) Turn main switch off.
- 19. REPLACING PHOTOGRAPHIC PAPER.** Photographic paper for the cardiette comes in rolls of 100 feet, 6-cm wide.
- a. **To check supply in magazine.** On front of magazine (fig. 11, part 11) is a circular disc (fig. 11, part 10) that covers a transparent red safety window. Turn this disc to one side and see how much paper is left on the supply roll. As an additional check on the supply of paper, several perforations appear along the edge of the paper 10 feet from the end of the roll.

b. To replace roll of paper in magazine. Lift magazine out of chassis. If any paper is left in the cardette between plate and roller, release it by drawing plate away from roller.

(1) If this is the first time you are replacing the paper and there is a small amount left in the magazine, open magazine in daylight and notice how the old roll is threaded.

(2) Take magazine to dark room. Unscrew and remove thumbscrew on side of magazine opposite viewing window. Lift cover off. Set open magazine down. Remove old roll and unwrap new.

(3) Unwind to the left about 6 inches of the new roll, glossy side toward you. Slide one edge of paper behind guide plate (fig. 12) in magazine and pass end through opening. Drop roll on spindle.

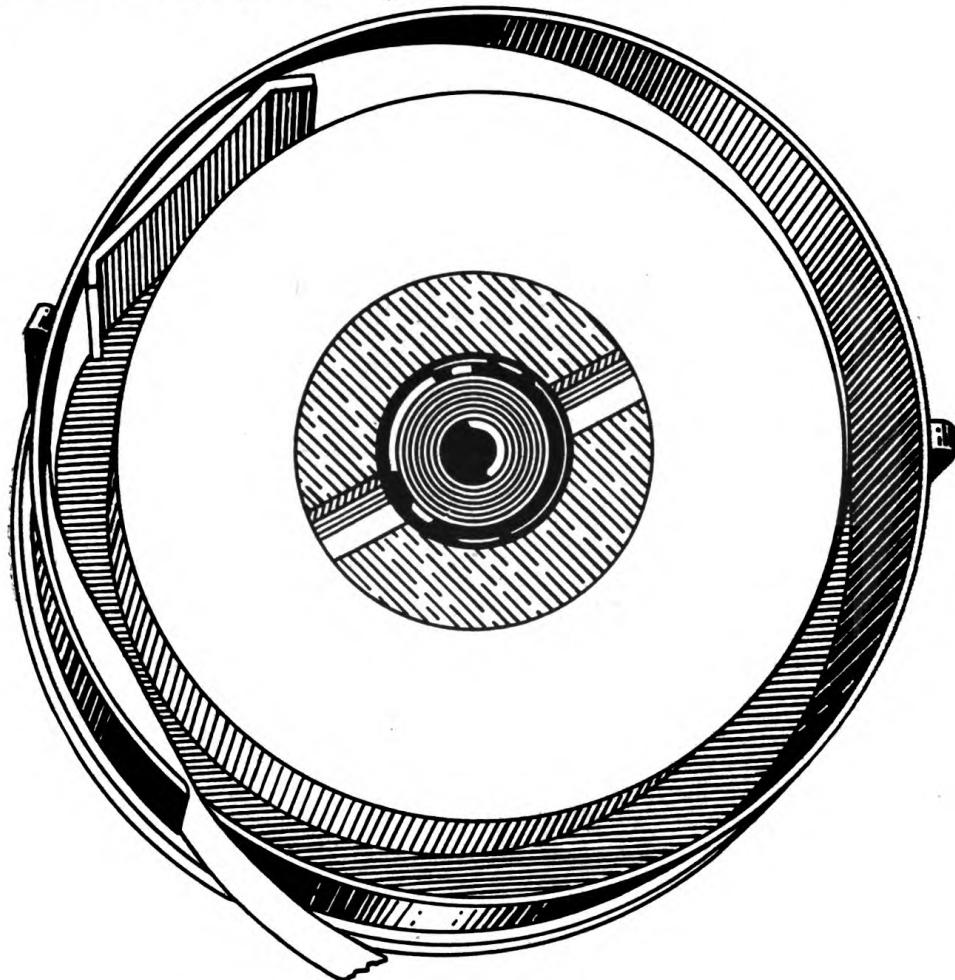
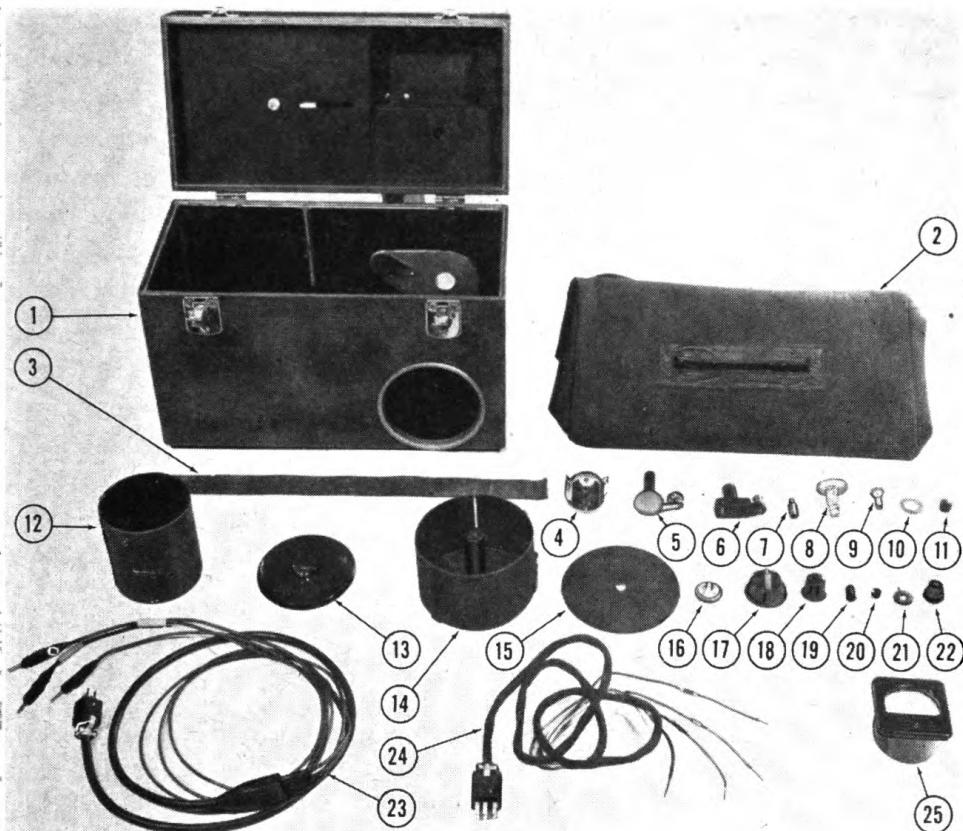


Figure 12. Camera magazine.

c. To replace magazine. Remove record container cover. Holding magazine, viewing window front, to one side of opening, direct the short strip of paper issuing from the magazine between plate and roller. Turn camera on and as the paper folds through, gradually lower the magazine in place. *Make sure that all the paper is taken up as the magazine is put back*, for excess paper folded under the magazine may stop the camera.



Nomenclature

1. 3R02218 Case, Carrying, Complete.
2. 3R02220 Cover, Carrying Case.
3. 3R02212 Band, Arm and Leg, Rubber.
4. 3R02210 Electrode, Limb Lead.
5. 3R02252 Electrode, Precordial Lead.
6. 3R02222 Handle, Winding.
7. 3R02256 Fuse, 1/200 Amp., 250 V.
8. 3R02234 Holder, Bulb, Complete.
9. 3R02202 Bulb, Galvanometer.
10. 3R02248 Disc, Stroboscopic.
11. 3R02254 Thumbnut, Battery.
12. 3R02224 Shell, Record Container.
13. 3R02226 Cover, Record Container.

Med. Dept. No.

14. 3R02228 Shell, Magazine, Paper.
15. 3R02230 Cover, Magazine, Paper.
16. 3R02232 Screw, Thumb, 1/4-20 X 5/16 Inch, 1 Inch Knurled Head.
17. 3R02244 Knob, Main Switch.
18. 3R02242 Knob, Control.
19. 3R02240 Knob, Camera, Off and Run.
20. 3R02246 Knob, Lead Marker.
21. 3R02236 Index, Footage.
22. 3R02238 Index and Knob, Advance Setting.
23. 3R02216 Leads, Patients.
24. 3R02250 Cable, Battery, External.
25. 3R02214 Voltmeter.

Figure 13. Portable cardiograph, Sanborn.

Section III. MAINTENANCE

20. TESTING THE BATTERIES. Three batteries are required for the operation of the instomatic cardiette; one *A* battery of $1\frac{1}{2}$ volts which lights the filaments of the vacuum tubes and the lamp bulb for photography; one *B* battery of 45 volts which supplies the voltage to the vacuum tubes; and one small flashlight cell which supplies the I MV for correct setting of the standardization.

a. The life of the batteries depends, to a great extent, on the amount of use. The *A* battery should provide approximately 18 hours actual operating use; the *B* battery 300 hours; the I MV battery from 6 months to 1 year.

The shelf life, or life without use, of *A* batteries (including the I MV battery) is about 1 year.

b. It may be expected that in average use the *A* battery will provide power for 180 patient tests, and the *B* for nearly 3,000 tests.

c. Test batteries at least once a month. If the apparatus is not used over long periods of time, check batteries before each test. The surest method is to make the following procedure standard during every test:

(1) *I MV "standardization" battery.* Turn main switch to "Std." Press I MV knob. Meter should register inside the broad I.MV line. If it registers below, the I MV battery should be replaced.

(2) "*A*" *battery.* Turn main switch to "A." Meter should register to right of red line; if it does not, replace *A* battery. As the *A* battery has the heaviest current drain, it will not—even when new—register at full voltage on the meter after the cardiograph has been running a few moments. This does not mean that the cell is about to deteriorate for the apparatus has been designed to operate satisfactorily until the "*A*" voltage swings to left of the red line.

(3) "*B*" *battery.* Turn main switch to "B." Meter should register to right of red line; if it does not, replace *B* battery.

21. REPLACEMENT OF BATTERIES. **a. To remove cardiette chassis from case.** Removal of chassis is necessary to reach the battery compartment. Removing the chassis from the case does not expose the paper. Remove record container, then turn winding handle counterclockwise to unscrew. To keep case from tipping over as the chassis is removed, turn apparatus around so that the cover rests against your body or have assistant hold the case. Lift chassis out by the lifting devices on either side of the panel. (Never use control panel for this purpose.) Close case and set to one side.

b. To put in new batteries. At front of apparatus, to left of record container housing, is the battery compartment, covered by a metal door. Slide door to left and remove.

(1) Five thumbnuts at bottom of case under battery compartment hold the two large batteries in place. Unscrew the thumbnuts and lift batteries out. *Be sure to save these thumbnuts as they are specially designed for use with the batteries;* have special metal inserts to make contact, and the ordinary thumbnut is entirely unsuitable. Spare thumbnuts are provided in an envelope in the cover for accessories.

(2) Because of the spacing of the terminals, the *A* and *B* batteries may be replaced only in the correct polarity. They are marked for polarity, and the plus terminal of the *B* and the minus terminal of the *A* enter the compartment first.

(3) Loose contacts may produce the irregular or "jumpy" beam. Tighten all thumbnuts as firmly as possible.

(4) The I MV battery is in the small compartment to the right; it is held in place by a clip. Lift old battery out and press the new battery into

place in the holder. The positive or center terminal faces the back; if battery is inserted incorrectly, the needle on the voltmeter will read backward when the I MV knob is depressed for standardization.

22. REPLACEMENT OF GALVANOMETER LAMP. **a.** Lift out black knob with white disc. As the lamp bracket is held securely in place, it may be necessary, in lifting the bracket, to apply some pressure of the fingers under the white disc. *Do not remove screw in knob.*

b. Two lamp bulbs are attached to under side of this unit. The lower bulb is the one in use; the upper bulb is the spare lamp. To remove either bulb, twist it slightly and pull out of socket.

c. The black guide mark on the bulb should be at the center top of the socket in line with a similar mark on the socket. This position insures uniform illumination and even photography.

d. Replace the unit in the cardiette with the lamp bulbs toward the front. Press unit well down in cardiette to insure good contact.

e. These lamp bulbs are especially made for the cardiograph. The voltage and current rating are not standard and the bulb has a special silver tip to insure good contact. Replacement bulbs should be ordered through the Medical Supply Officer.

23. TIMING THE MOTOR. **a. Motor speed.** The 2-second interval marks on the record are a constant check of motor speed. Two seconds' time is represented on the record by 50 fine vertical lines (or two heavy lines). A decreased or increased number of lines between two successive marks would indicate some error in motor speed.

(1) An error up to 5 percent in camera speed is permissible for routine electrocardiographic work.

(2) *If 2-second mark does not appear.* This marker was incorporated in the instrument as an independent check of the motor speed. Since it is operated by a balance wheel, hair spring, and escapement mechanism similar to that found in ordinary clocks, it is possible for the balance wheel to be caught sometimes in a so-called "dead" center position. Under these conditions, the clock works will not start and the 2-second marks will not appear on the record. If, however, the camera lever is snapped off and on again, the clock mechanism will be pushed past that center and will operate normally.

b. To check motor speed. (1) *To expose stroboscope and governor adjustment.* This may be done with the cardiograph in the case. Beside the winding handle is a small knurled knob. Turn counterclockwise to open shutter. The stroboscope is the round disc with 24 black spokes.

(2) *Methods of checking motor speed.* Two methods are given—for localities where the power supply is 60-cycle alternating current and for localities where d-c only is available.

(a) *Remove paper magazine.* Illuminate stroboscope with an ordinary lamp running on 60-cycle alternating current. Start camera. The stroboscope is

so designed that the flickering of a 60-cycle alternating current lamp synchronizes with the spokes on the stroboscope if the timing is correct. The black spokes on the revolving disc then appear to stand still while the camera is running. The effect is more pronounced if a neon lamp or a modern fluorescent light is used as a light source. If camera speed is too fast, the black spokes will appear to move in the direction of rotation, or counterclockwise; if too slow, they will appear to move clockwise. A slight travel in either direction does not warrant further adjustment as the testing device is extremely sensitive.

(b) For d-c localities, run a short straight-line test and count the lines between two 2-second interval marks. For exact speed there should be 50 fine lines.

(3) *To change motor speed.* With a screw driver turn screw in center of stroboscope clockwise until another screw—the governor adjusting screw—appears in the small round opening at left of stroboscope. To increase speed turn the governor adjusting screw slightly clockwise. To decrease, turn slightly counterclockwise.

Section IV. REPAIR

24. GENERAL. Operator should attempt no repairs in addition to the maintenance as already outlined. The adjustments on this instrument are of a delicate nature and should not be changed except by trained medical repair personnel.

Appendix

1. Item 36260 Cardiograph, Portable, Standard Nomenclature List of Parts, General Electric X-ray Corporation, Model No. B.

Medical Dept. No.	Nomenclature	Figure No.
<i>Medical Department items</i>		
77160-02	BATTERY, DRY CELL: "C"; 1½ Volt; 1 Cell. 2 on Type 4 or Type 5.	8
77160-10	BATTERY, DRY CELL: "A"; 1½ Volt; 1 Cell. 2 on Type 4 or Type 5.	8
77160-22	BATTERY, DRY CELL: "B"; 45-Volt; 30 Cells. 1 on Type 4.	—
77160-26	BATTERY, DRY CELL: "B"; 45-Volt; 30 Cells. 2 on Type 4; 3 on Type 5.	8
<i>Uncommon parts</i>		
23Ro2002	BULB, GALVANOMETER.	10
13Ro2004	TUBE-PACK.	8
13Ro2006	CONTROL, SENSITIVITY.	9
13Ro2008	CONTROL, FILAMENT.	9
13Ro2010	ELECTRODE, PATIENT, LIMB LEAD: With thumbnut.	10
13Ro2012	BAND, ARM AND LEG, RUBBER.	10
13Ro2014	VOLTMETER, TYPE BU: With clamp.	8
13Ro2016	ELECTRODE, PRECORDIAL LEAD: With binding post, thumbnut, and handle.	10
3Ro2018	COVER, BATTERY COMPARTMENT.	—
3Ro2020	COVER, TUBE COMPARTMENT.	—
3Ro2022	WIRE, GROUND, COMPLETE: With clamp, plug, tip, and thumbscrew.	8
3Ro2024	CLAMP, GROUND: For ground wire assembly.	—
3Ro2026	CABLE, PATIENT'S, COMPLETE: With tips and bushing.	8
3Ro2028	KNOB, STANDARDIZATION SWITCH.	—
3Ro2030	PLUG, MAIN SWITCH: With sleeve and knob.	9
3Ro2032	LINK, CONNECTING, BATTERY.	9
3Ro2034	KNOB, CONTROL.	9
3Ro2036	KNOB, CONTROL, INDEXED.	9
3Ro2038	CRANK: For motor.	10
3Ro2040	INDICATOR, FOOTAGE, COMPLETE: Assembly.	10
3Ro2042	INDEX, FOOTAGE.	10
3Ro2044	INDEX, ADVANCE SETTING.	10
3Ro2046	BULB, NEON: G-E No. 10, Medium Screw Base, 1 Watt, 105/125 Volt.	10

Medical Dept. No.	Nomenclature	Figure No.
3Ro2050	KNOB, LEAD MARKER.	10
3Ro2052	CABLE, "A" BATTERY, AUXILIARY, COMPLETE: Assembly.	8

2. Item 36260 Cardiograph, Portable, Standard Nomenclature List of Parts, Sanborn Instomatic.

Medical Department items

77160-04	BATTERY, DRY CELL: 1½ Volt; 1 Cell. (Serial No. 2172 and higher.)	—
77160-08	BATTERY, DRY CELL: "A"; 1½ Volt; 1 Cell. (Serial No. 871-2171 inc.)	—
77160-10	BATTERY, DRY CELL: "A"; 1½ Volt; 1 Cell. (Serial No. 2172 and higher.)	—
77160-18	BATTERY, DRY CELL: "B"; 45 Volt; 30 Cells. (Serial No. 871-2171 inc.)	—
77160-20	BATTERY, DRY CELL: 45 Volt; 30 Cells. (Serial No. 871-2171 inc.)	—
77160-26	BATTERY, DRY CELL: "B"; 45 Volt; 30 Cells. (Serial No. 2172 and higher.)	—

Uncommon parts

23Ro2202	BULB, GALVANOMETER.	13
13Ro2204	TUBE, POWER AMPLIFIER, 1C5 GT/G.	—
13Ro2205	TUBE, TWIN AMPLIFIER, No. 19.	—
13Ro2206	CONTROL, SENSITIVITY.	—
13Ro2208	CONTROL, BEAM.	—
13Ro2210	ELECTRODE, LIMB LEAD: With thumbscrew.	13
13Ro2212	BAND, ARM AND LEG, RUBBER.	13
13Ro2214	VOLTMETER.	13
13Ro2216	LEADS, PATIENTS.	13
3Ro2218	CASE, CARRYING, COMPLETE: With compartments, handle, hinges, and hasps.	13
3Ro2220	COVER, CARRYING CASE: Gabardine.	13
3Ro2222	HANDLE, WINDING.	13
3Ro2224	SHELL, RECORD CONTAINER: Complete with cutter.	13
3Ro2226	COVER, RECORD CONTAINER.	13
3Ro2228	SHELL, MAGAZINE, PAPER: With guide plate and center core.	13
3Ro2230	COVER, MAGAZINE, PAPER.	13
3Ro2232	SCREW, THUMB, ¼ - 20 X 5/16 INCH, 1 INCH KNURLED HEAD: For attaching paper magazine cover.	13
3Ro2234	HOLDER, BULB, COMPLETE: With knob, white plastic disc, and lamp holder frame.	13

Medical Dept. No.	Nomenclature	Figure No.
3Ro2236	INDEX, FOOTAGE, RED PLASTIC.	13
3Ro2238	ADVANCE SETTING, INDEXED.	13
3Ro2240	KNOB, CAMERA, OFF AND RUN, PLASTIC.	13
3Ro2242	KNOB, CONTROL, PLASTIC: For beam control and sensitivity control.	13
3Ro2244	KNOB, MAIN SWITCH, PLASTIC.	13
3Ro2246	KNOB, LEAD MARKER, PLASTIC.	13
3Ro2248	DISC, STROBOSCOPIC.	13
3Ro2250	CABLE, BATTERY, EXTERNAL.	13
13Ro2252	ELECTRODE, PRECORDIAL LEAD, COMPLETE: With center post, terminal post, thumbscrew, and bakelite handle.	13
² 3Ro2254	THumbnut, BATTERY.	13
² 3Ro2256	FUSE, 1/200 AMP., 250 V.	13

¹ To be requisitioned, when required, from the supply depot.

² Spare of these parts are to be maintained with the apparatus, and can be requisitioned from the supply depot.

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